Fishlake National Forest

Oil & Gas Leasing Final Environmental Impact Statement

Supplemental Air Quality Modeling Report: 1-hr NO_2 and 1-hr SO_2

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Table of Contents

List of Figures

List of Tables

List of Appendices

Abbreviations and Acronyms

AP-42	US EPA Guidance document on air pollution emission factors
EIS	US Environmental Impact Statement
DEIS	Draft US Environmental Impact Statement
FEIS	Final US Environmental Impact Statement
EPA	United States Environmental Protection Agency
FLAG	Federal Land Managers' Air Group
ISCST3	US EPA Industrial Source Complex air quality model, version 3
MMbtu	Million British Thermal Units (btu); units of heat measurement
Mscf	Million standard cubic feet; measurement unit for gas volume
NOx	Nitrogen oxides
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
FNF	Fishlake National Forest
NO_2	Nitrogen dioxide
NWS	National Weather Service
O&G	Oil and Gas
PM_{10}	Particulate matter less than 10 microns in diameter
ROI	Radius of Impact
SOx	Sulphur oxides
SO_2	Sulfur dioxide
UDAQ	Utah Division of Air Quality
UDEQ	Utah Department of Environmental Quality
$\mu g/m^3$	Micrograms per meter cubed
USGS	United States Geological Survey
USFS	United States Forest Service
WRAP	Western Regional Air Partnership

1.0 PURPOSE

This modeling report describes an air quality modeling analysis prepared to address comments received by the Fishlake National Forest (FNF) on their Draft Oil & Gas (O&G) Leasing Environmental Impact Statement (DEIS) submitted in February 2010. The specific comment this report addresses is the request to evaluate 1-hour nitrogen dioxide (NO_2) and 1-hour sulphur dioxide (SO_2) impacts, which were not included in the February 2010 modeling analysis. This analysis is meant to act as an addendum to the initial modeling report submitted with the DEIS. As a result, this modeling effort will follow the general modeling methodologies outlined in the DEIS modeling report. That approach has been reviewed and commented upon by federal and State of Utah representatives.

Unlike a project specific modeling analysis, the modeling completed for this project utilizes a screening methodology to quickly estimate potential impacts of O&G development emissions at the leasing/exploration stage. This screening methodology was developed and verified for 1-hr nitrogen oxides (NOx) and sulphur oxides (SOx) for this project. The screening methodology will help Forest Service staff in their planning, by identifying whether impacts from potential future development scenarios will safely be below impact thresholds, or if further analysis will be required before air quality impacts can be shown to be within acceptable ranges.

The analyses described in this report will support the Final Environmental Impact Statement (FEIS) process by preparing a 1-hr NOx and SOx screening tool that land managers may use to estimate air quality impacts associated with potential development. The analyses are based upon conservative estimates of emissions from potential Oil & Gas activity and the atmospheric dispersion of those emissions. As a result of this conservatism, projects shown by this screening method to have impacts within acceptable ranges would clearly meet air quality impact limits in a site specific impact analysis. For all other potential future development of O&G activities identified in the leasing EIS, project specific air quality analyses would be required using appropriate project and site specific information in order to more closely identify potential impacts. While the screening method provides an efficient tool for land managers making leasing decisions it does not represent a full regulatory air quality impact analyses that may be required to permit future, individual O&G activities under existing state and federal air quality regulations.

The modeling analyses described in this report will only address 1-hour NOx and 1-hour SO_2 impacts and will act as an addendum to the modeling report provided with the FNF's DEIS.

2.0 BACKGROUND / OVERVIEW

2.1 Oil & Gas Leasing Activity

The FNF evaluated O&G leasing across its domain in a DEIS submitted in 2010. The proposed actions and alternatives in that EIS were structured to conservatively evaluate potential impacts from a range of O&G activities the United States Forest Service (USFS) considers reasonably foreseeable, and not any project specific development. The DEIS provided specific definitions of proposed actions and/or alternatives.

The analysis in this modeling report is meant to amend the DEIS modeling report to allow for the assessment of impacts for the new 1-hr NOx and 1-hr National Ambient Air Quality Standards (NAAQS). As with the previous modeling if the conservative analyses in this modeling report clearly documents impacts within acceptable ranges set by air quality regulations, Federal Land Manager's Air Group (FLAG) guidance, or a leasing EIS, then additional modeling or impact assessments may not be needed. If a future development scenario is proposed which cannot be shown by the screening tables to meet those acceptable impact thresholds, then the proposed development could not be justified by these screening analyses. Instead, any such development would require a follow-up National Environmental Policy Act (NEPA) analysis and refined air quality analyses that would include project and site specific information in order to further identify potential impacts.

2.2 Initial Screening Model Analysis

The initial aspect of the dispersion modeling analyses described here was to prepare a representative screening analysis that can be used by the USFS personnel to quantifiably estimate potential impacts of O&G exploration planning and leasing. The potential emissions associated with Oil & Gas exploration and possibly subsequent development of those resources are conservatively estimated. The dispersion of those emissions was also conservatively estimated using worst-case screening meteorological data develop in the USEPA's MAKEMET program. The result is a screening analysis that shows maximum potential impacts associated with a given level of Oil & Gas activity. The maximum potential impact estimates from the screening analyses can be compared to benchmark ambient air standards, increments, and thresholds in order to determine if the conservative screening analyses show that an action being considered meets state and federal impact limits. Because the screening analysis is based upon conservative assumptions, a site specific analysis of impacts associated with a specific proposal could show lower impacts than those conservatively estimated in the screening analyses presented here.

The results of these analyses are normalized sets of conversion factors in tables for various source / receptor elevation differences at 22 graduated source / receptor distances. The tables indicate the predicted impacts in $\mu g/m^3$ for each 1 lb/hr of emissions. The details of the conversion factor tables were described in the DEIS modeling protocol for this project after refinement with USFS Air Program Manager, Bud Rolofson. The screening values can be applied to subsequent O&G development scenarios by estimating the air emissions (in lbs/hr) anticipated from those scenarios and multiplying them by the table screening values to determine a screening estimate of potential ambient air quality impacts. Those impacts can be compared against applicable air quality standards, increments, and thresholds to provide an initial estimate of a range of management options based upon air quality impacts. Ambient air potential impact information will allow land managers to estimate the potential for air quality impacts for subsequent levels of O&G development projects.

2.3 Two Oil & Gas Development Scenarios for Evaluation of Initial Screening Table

After initial development of the screening model runs, the reasonableness of the screening tables were confirmed with site specific analyses of USFS identified potential development scenarios to ensure their reasonableness for development scenarios consistent with forest service (FS) expectations. The two potential development scenarios recommended to be considered are:

1. Scenario 1 -- Individual exploratory wells: over the next 15 years, 45 wells are estimated on the Fishlake NF. This scenario spans a period of three weeks for construction, three months of drilling activity, and two weeks of reclamation.
2. Scenario 2 -- A 10 to 15-well directional drilling development which features two to three well pads.

The USFS notes that primary energy development is expected to be for crude oil, however, natural gas could likely be found as well. The USFS has surmised gas will not be found in volumes that would support commercial development. Gas might be flared onsite or produced in quantities to either fuel onsite engines or support limited development, storage, and transport via trucks.

Air quality modeling was performed for each of these development scenarios to assess potential criteria air quality pollutant (1-hr NO_x, and 1-hr SO_2) concentrations. That information was used to confirm the representativeness, conservatism, and accuracy of the screening modeling analyses. Those specific development scenario model analyses confirmed the conservative nature of the screening runs in most scenarios by showing that predicted air quality impacts from actual development scenarios were lower than the conservative estimates from the screening tables prepared in this analysis. Therefore, impact estimates from the screening tables can be considered as conservative estimate based upon that level of activity as long as the activity occurs consistent with the assumptions included in the screening analyses.

3.0 MODELING METHODOLOGY

3.1 Brief Description of AERMOD Modeling Programs

AERMOD, which is utilized by Utah Division of Air Quality (UDAQ) to assess impacts for minor sources, was used to conservatively estimate impacts in the near field (within 50 kilometers of the activity being modeled). AERMOD also represents the United States environmental Protection Agency's (EPA) preferred model for impacts assessments within 50km of a facility. AERMOD was applied as recommended in USEPA's Guideline on Air Quality Models and consistent with USEPA's clarification memorandum for 1-hr NOx and SOx.

AERMOD does not include any air chemistry analyses; it simply tracks emissions without chemical transformations during transport in the near field based upon meteorological data from local observation stations.

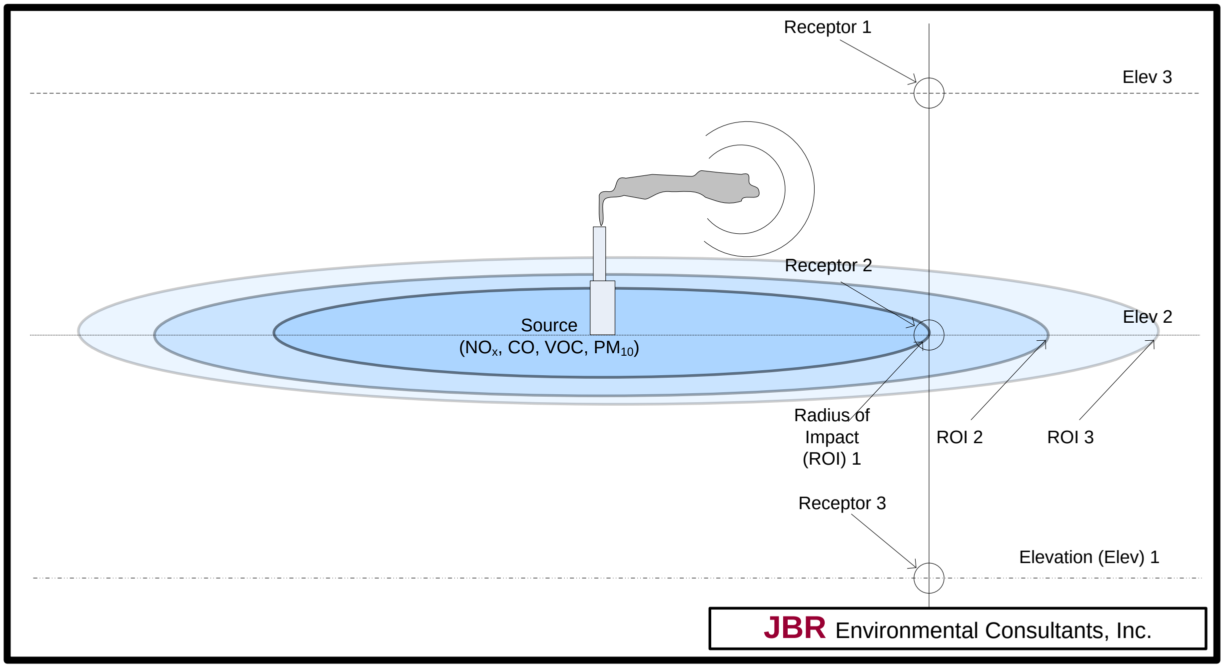
3.2 General Screen Approach for this Analysis

Figure 3.2-1 on the following page visually depicts the screening modeling approach for the AERMOD runs.

Impacts for each pollutant were evaluated at a set of predetermined elevations in relation to the source and radius of impact (ROI, circles of increasing radius centered around the source). In the screening table runs, seven elevation scenarios were considered - one more than proposed in the project's modeling protocol based upon comments received from UDAQ. The 22 ROI utilized were unchanged from those proposed in the DEIS modeling protocol. At the intersection of each of the seven elevations and the 22 ROIs, a receptor is identified. Receptors are defined as the locations where quantitative air quality impacts are predicted.

Various types of receptor grids can be used by defining points on a polar coordinate system (see Figure 6.0-1), a Cartesian (x-y) coordinate system, or a combination of both systems. The receptor locations are documented in the receptor network section below. Maximum model predicted impact values on each radius from the source were reported and included in the screening tables (see Appendix A).

Figure 3.2-1 Modeling Methodology



3.3 Testing Applicability of Initial Screening Table

To evaluate applicability of the screening table results, AERMOD modeling was also performed for the specific development scenarios defined in Section 2.0 of this report. Those specific development scenarios were modeled at locations the Fishlake NF identified as conceivable for O&G development.

The emission sources and emission rates for these runs were identified based upon expectations for future development provided by the Fishlake NF. The section below provides more detail on model emission sources. The model emissions were distributed across the development area consistent with USFS descriptions of the development scenarios.

4.0 MODEL SOURCE DATA

4.1 Equipment Considerations for Preparing Emission Inventories

Assessments of equipment needed to support oil exploration and/or oil field development with some possibility of gas resources were prepared generally, and also specifically, for the two development scenarios. An inventory of emissions from all emission sources identified to support the potential oil (and possibly gas) development was prepared. Conservative assumptions were made of the type, size, and number of pieces for each equipment type, consistent with guidance from the USFS and the USEPA. Although natural gas was not expected to be found in economical quantities, a heated oil/gas/water separator, a compressor to move developable gas, and a gas flare were assumed in each oil field development scenario.

As recommended by the USEPA, emissions from mobile and stationary combustion sources assume that engines associated with the potential development meet emission standards from recent EPA tiered emission limits. Generally, equipment was assumed to meet the minimum tiered emission requirements from approximately the last five years, allowing flexibility to the operator because of the comparatively small size of potential development activity anticipated. EPA reviewed and approved the engine emission estimates before the modeling analyses were performed. EPA indicated that more recent engines would likely be required for resource development larger in scale or concentration than the scenarios considered in this analysis.

Emission estimates assume that all vehicular travel is on unpaved surfaces, and that there is no electrical power service onsite, so all major equipment onsite is fossil fuel fired.

In the screening modeling analyses, all model sources were assumed to be collected at a central point, with grid origin with relative coordinates (0,0). That gridding allowed the screening model results to be used to estimate impacts from a variety of development options, from simple projects like an individual exploratory well to more complicated ones like expansive well field developments.

Table 4.1-1 below documents the types of equipment associated with air emissions under the screening model scenario. The emission data from the screening modeling analyses includes the total onsite emissions associated with potential development normalized at 1.0 pound per hour.[1] These emissions are allocated proportionally among equipment and emission stacks as point sources (stacks) or area sources (areas from which non-stack fugitive emissions like dust occur) consistent with regional development scenarios. To be conservative, the emissions profile shown here assumes oil extraction efforts for each scenario, with a small component consistent with gas flaring or processing. The screening model emissions were allocated in model emissions sources listed in Table 4.1-1 with associated stack parameters. The emissions values found in Table 4.1-1 represent the normalized screening emission rates. They represent the proportion of overall emissions of the pollutant from that source in the screening model, not the actual total emissions calculated for each piece of equipment.

[1] In the screening model, the emissions entry for each source represents the percentage of the emissions of that pollutant for that source. The sum of the normalized emissions for the entire development is 100%, or 1.00 lb/hr.

Table 4.1-1 Screening Model Sources and Source Parameters

Point Source ID	Source Description	Easting (X)	Northing (Y)	Stack Height	Temp	Exit Velocity	Stack Diam.	NOx	SO_2
		(m)	(m)	(ft)	(°F)	(fps)	(ft)	(lb/hr)	(lb/hr)
DRE	Drill Rig Engine	0.0	0.0	15.0	950.0	75.0	1	0.2950	0.0024
WP1	Well Pump	0.0	0.0	10.0	775.0	45.0	0.667	0.4610	0.9954
RICE / Turbine emission totals								0.7561	0.9978
Flare	Exploration Flare	0.0	0.0	85.0	1000.0	51.0	1.5	0.0384	0.0000
Flare	Production Flare	0.0	0.0	85.0	1000.0	51.0	1.5	0.0852	0.0000
HT1	Heater Treater	0.0	0.0	20.0	180.0	15.0	0.67	0.0332	0.0014
Use or Flare NG emission totals								0.1568	0.0014
DHY1	Dehydrator	0.0	0.0	30.0	200.0	8.0	1	0.0033	0.0001
CM1	Compressor Engine	0.0	0.0	25.0	760.0	95.0	1	0.0768	0.0007
NG development emission totals								0.0802	0.0008
Dust: Ground dist, vehicles, etc …				Release Height	Radius of Circle	Number of Vertices	Initial Vertical Dimen.		
Area Circle Source ID				(ft)	(ft)		(ft)		
	Fugitives	0.0	0.0	10.0	300.0		20	0.0070	0.0000
TOTAL EMISSIONS								**1.000**	**1.000**

► The uppermost shaded **table section** includes **stack emissions from reciprocating engines or turbines**. This emission category includes well pumps needed to extract oil as well as onsite well drilling rigs with diesel powered drilling engines. Consistent with emissions from regional oil development fields, the total onsite emissions from this source category represented the majority of emissions in the normalized screening model analysis. The emissions of SO_2 from the well pumps, approved by EPA reviewers, are conservative because they are from the US EPA Guidance document on air pollution emission factors (AP-42) emission factor guidance document from before recent efforts to reduce diesel fuel sulfur content. This is unlike the AP-42 emission factors for the larger well drilling engine which accounted for the low sulfur fuel that will be required during the project's operational phase.

► The first unhighlighted section includes **emissions associated with processing or using natural gas** expected to be found at least in small quantities in oil development fields. The total onsite emissions from this category make up about 10 percent of total emissions for most pollutants, though flaring could make up a larger percentage of emissions of sulfur dioxide and related compounds.

► The second shaded **section** includes **emissions** that would be expected with **low volumes of natural gas development**. Because developable natural gas is not expected in any appreciable volume, this category represents no more than two percent of the normalized 1.0 lb/hr emissions in this screening analysis.

► The lowest unhighlighted **table section represents onsite fugitive emissions** not vented through a stationary stack. This category includes fugitive dust emissions from vehicular exhaust and road dust, wind erosion from disturbed ground surfaces, and emissions including valve and tank leakage from handling resources and supplies. This category represents the major component for particulate emissions, but includes lower percentages of emissions from the other criteria pollutants studied (NOx and SO_2).

► The **bold red Total Emissions** in the highlighted bottom section under each pollutant's column show that cumulative screening model emissions for each pollutant were 1.0 pound per hour.

4.2 Evaluating Applicability of Model Results Screening

To evaluate applicability of the results from the screening modeling analyses, model source data sets were prepared for the specific well field development scenarios described as reasonable by local USFS personnel. The development scenario proposed by the Fishlake NF and modeled for this analysis is understood to be based upon the one existing energy field development there.

For the specific development scenario modeling analyses, model sources were identified and their emissions estimated based upon expected operating scenarios. They were allocated across the development field consistent with descriptions of each scenario provided by the NF. Each of the well field development scenarios were assumed to cover three to three and a half square miles, include specified numbers of wells footprints, and be operated consistent with scenario information provided by the NF. Each scenario included the volume of vehicular traffic expected to be needed to support those efforts.

4.3 References

References utilized in preparing the emission inventory included Utah State Government's "Analysis of Emissions from Oil and Gas Wells in Utah," the Oil & Gas Emission Inventory Workbook for the Uinta Basin Study, similar data from the Four Corners Oil & Gas Development Study, information from existing oil field development on the Dixie and Fishlake NF, and regional and national O&G field emission analyses and emission factors.

The Uinta Basin Study was especially helpful in supplying county-wide cumulative inventories of air emissions from recent development of O&G field development in Uinta and Duchesne Counties, Utah. That data, similar information from a Four Corners area study, and information about existing O&G field developments on the Dixie and Fishlake NFs provided the main basis for allocating the particulate matter less than 10 microns in diameter (PM_{10}), NOx, and SO_2 emissions among source types and categories in the model. This information was also used in the screening model runs to allocate the normalized 1 lb/hr of emissions proportionally among a variety of emissions sources, each with representative stack parameters and model emissions scenarios. This also helped in the quality assurance reviews of emissions inventories for the specific development scenario modeling analyses. It ensured that the model emissions were allocated among likely sources consistent with emission inventories from existing regional and local O&G developments.

Vehicle traffic volume estimates were prepared consistent with the "Highway Freight Traffic Associated with Development of Oil and Gas Wells" document prepared in 2006 by Daniel Kuhn of the Utah Department of Transportation.

4.4 Fishlake National Forest Development Scenario Modeling (Scenario 2)

The Fishlake NF development scenario model consisted of one, 10 to 15-well field on the Fishlake NF using directional drilling technology. The scenario described two or three production pads with each pad hosting up to five wells each, using directional drilling technology and an offset distance of one-half mile. The modeled scenario included 12 wells on three pads. Total actual ground disturbance including the discovery well, central production facilities pad, production pads, water disposal well, new access roads, reconstruction of existing roads, pipelines and power lines, and a truck loading facility is estimated at 122-acres. The area within the perimeter of the field including pads, pad access roads, and interior pipelines and power lines, and undisturbed areas between could vary, but is estimated at approximately 3.0 square miles using a well spacing of 160 acres (or ½ mile distance between down-hole well termini (directional drilling).

Table 4.5-1 on the following page documents the model emissions sources used to simulate emissions from this well field development scenario. As with the Dixie NF development scenario modeling analysis, on the ground considerations were added by distributing the model emission sources over three square miles. The sources were distributed in a manner consistent with the anticipated spread of the well field scenario at a conceivable location in the Fishlake NF, with variations in elevations across the development field and across the receptor network based upon actual topography in the modeled location. Figures in the next section of this document will provide a visual representation of their layout.

Table 4.5-1 Fishlake National Forest Directional Drilling Oil Field Development Scenario Model Sources and Source Parameters

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Stack Height	Temp	Exit Velocity	Stk Diam	NOx	SO_2
POINT SOURCES		**(m)**	**(m)**	**(ft)**	**(ft)**	**(°F)**	**(fps)**	**(ft)**	**(lb/hr)**	**(lb/hr)**
DRE	Drill Rig Engine	381195	4277425	2503	15	950	75	1.00	8.47	0.01
PFLAR	Production Flare	381145	4277415	2495	100	1000	55	1.50	3.55	0.00
COMPR	Compressor Engine	381245	4277415	2511	25	760	95	1.00	2.20	0.00
HT1	Heater Treater	380325	4276795	2464	20	180	15	0.67	0.05	0.00
HT2	Heater Treater	382265	4277435	2584	20	180	15	0.67	0.05	0.00
HT3	Heater Treater	380813	4278408	2487	20	180	15	0.67	0.05	0.00
HT4	Heater Treater	381195	4277465	2502	20	180	15	0.67	0.05	0.00
HT5	Heater Treater	380245	4276815	2465	20	180	15	0.67	0.05	0.00
HT6	Heater Treater	380345	4276815	2464	20	180	15	0.67	0.05	0.00
HT7	Heater Treater	380345	4276715	2464	20	180	15	0.67	0.05	0.00
HT8	Heater Treater	380245	4276715	2465	20	180	15	0.67	0.05	0.00
HT9	Heater Treater	382245	4277515	2592	20	180	15	0.67	0.05	0.00
HT10	Heater Treater	382345	4277515	2581	20	180	15	0.67	0.05	0.00
HT11	Heater Treater	382345	4277415	2572	20	180	15	0.67	0.05	0.00
HT12	Heater Treater	382245	4277415	2583	20	180	15	0.67	0.05	0.00
DHY1	Dehydrator	380793	4278488	2480	30	200	8	1.00	0.05	0.00
DHY2	Dehydrator	380893	4278488	2470	30	200	8	1.00	0.05	0.00
WP1	Well Pump	380893	4278388	2492	10	775	45	0.67	0.66	0.21
WP2	Well Pump	380793	4278388	2493	10	775	45	0.67	0.66	0.21
WP3	Well Pump	381195	4277425	2503	10	775	45	0.67	0.66	0.21
WP4	Well Pump	381145	4277415	2495	10	775	45	0.67	0.66	0.21
WP5	Well Pump	381245	4277415	2511	10	775	45	0.67	0.66	0.21
WP6	Well Pump	380325	4276795	2464	10	775	45	0.67	0.66	0.21
WP7	Well Pump	382265	4277435	2584	10	775	45	0.67	0.66	0.21
WP8	Well Pump	380813	4278408	2487	10	775	45	0.67	0.66	0.21
WP9	Well Pump	381195	4277465	2502	10	775	45	0.67	0.66	0.21
WP10	Well Pump	380245	4276815	2465	10	775	45	0.67	0.66	0.21
WP11	Well Pump	380345	4276815	2464	10	775	45	0.67	0.66	0.21
WP12	Well Pump	380345	4276715	2464	10	775	45	0.67	0.66	0.21

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elevation	Release Height	Horiz Dim	Vert Dim	NOx	SO_2
VOLUME SOURCES		(m)	(m)	(ft)	(ft)	(ft)	(ft)	(lb/hr)	(lb/hr)
ORD1	outer road	381195	4276306	2484	2.0	100	6.0	0.075	
ORD2	outer road	380641	4276454	2477	2.0	75	6.0	0.075	
ORD3	outer road	380235	4276860	2465	2.0	75	6.0	0.075	
ORD4	outer road	380086	4277415	2471	2.0	100	6.0	0.075	
ORD5	outer road	380235	4277969	2498	2.0	75	6.0	0.075	
ORD6	outer road	380641	4278375	2524	2.0	75	6.0	0.075	
ORD7	outer road	381195	4278524	2490	2.0	100	6.0	0.075	
ORD8	outer road	381750	4278375	2542	2.0	75	6.0	0.075	
ORD9	outer road	382156	4277969	2586	2.0	75	6.0	0.075	
ORD10	outer road	382304	4277415	2576	2.0	100	6.0	0.075	
ORD11	outer road	382156	4276860	2564	2.0	75	6.0	0.075	
ORD12	outer road	381750	4276454	2494	2.0	75	6.0	0.075	
IRD1	inner road	380883	4276752	2478	2.0	75	6.0	0.075	
IRD2	inner road	380533	4277102	2480	2.0	75	6.0	0.075	
IRD3	inner road	380533	4277727	2504	2.0	75	6.0	0.075	
IRD4	inner road	380883	4278077	2497	2.0	75	6.0	0.075	
IRD5	inner road	381508	4278077	2545	2.0	75	6.0	0.075	
IRD6	inner road	381858	4277727	2562	2.0	75	6.0	0.075	
IRD7	inner road	381858	4277102	2525	2.0	75	6.0	0.075	
IRD8	inner road	381508	4276752	2527	2.0	75	6.0	0.075	

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Rel Ht	Radius of Circle	Vert Dim	NOx	SO_2
		(m)	(m)	(ft)	(ft)	(ft)	(ft)	(lb/hr)	(lb/hr)
WELPAD1	Disturbed area - well pad	380295	4276765	2464	0	282.7	2.0		
WELPAD2	Disturbed area - well pad	382295	4277465	2584	0	282.7	2.0		
WELPAD3	Disturbed area - well pad	380843	4278438	2485	0	282.7	2.0		
CENTPROC	50 acres dist center proc	381195	4277415	2503	0	832.6	2.0		

4.5 Fugitive Emissions in the Development Scenario Modeling

The development scenario model runs include area and/or volume sources to assess the impacts of criteria pollutant emissions from vehicular traffic. The onsite emissions were evenly distributed around the facility in the model, with concentrations relatively even across the area. This is considered conservative in this analysis, where the nearest receptors are 0.25 kilometers (0.155 miles) away, closer to the center of activity than some of the wells. The percentages of overall traffic emissions that occur within the project boundary, as opposed to outside that boundary, were estimated high. Road and disturbed area emissions occurring outside the identified project area are included in the emissions inventory, but their impacts were not modeled.

5.0 MODEL FACILITY AND SOURCE LAYOUT

The emissions scenarios for the screening table runs included eight model emission sources: seven point sources, and a fugitive area source. These runs were scaled to be representative of actual emissions from anticipated O&G development.

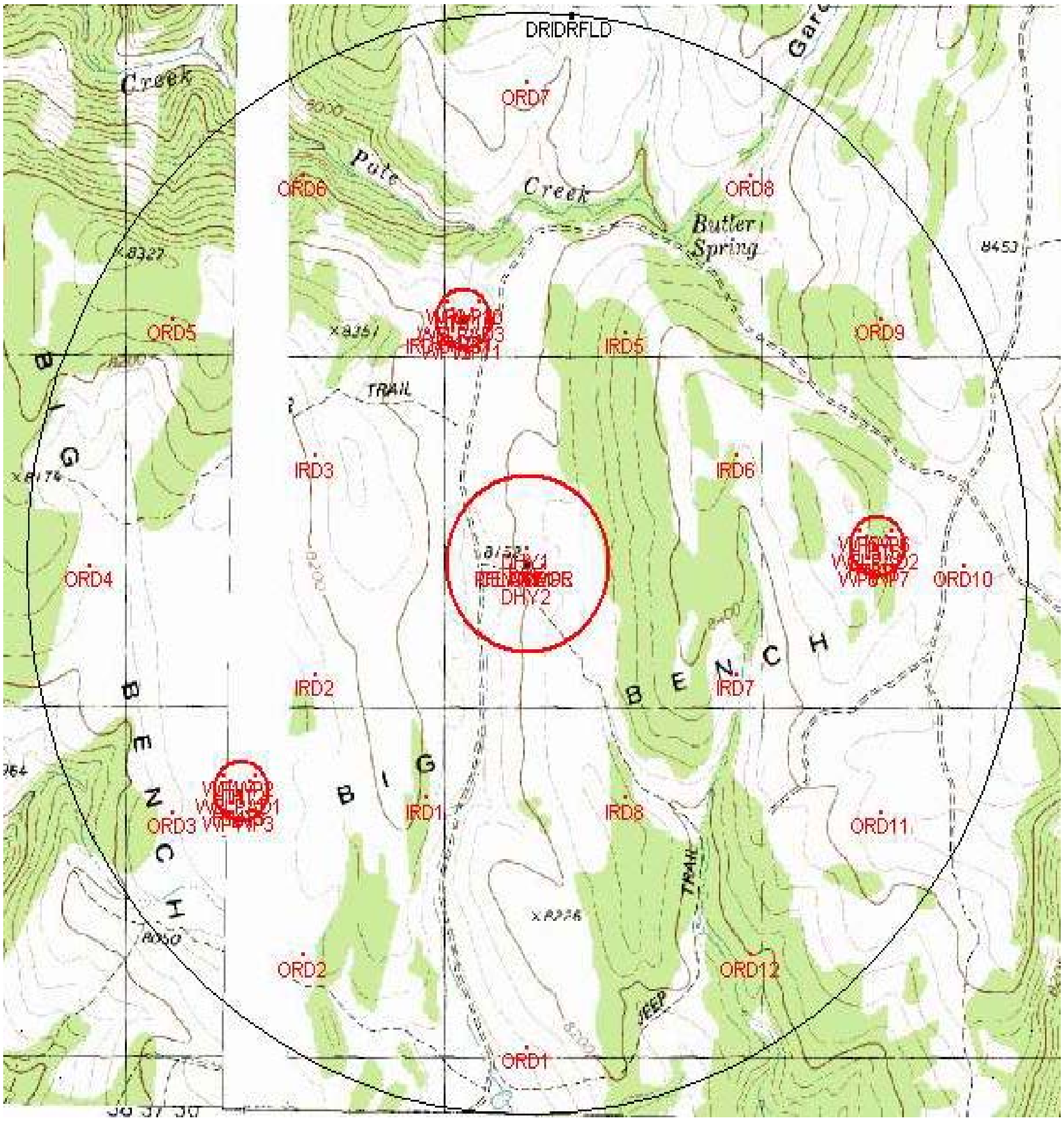
The screening tables prepared from the screening runs were checked for accuracy. The results were compared to the development scenario runs with model emissions laid out using on the ground locations in the Fishlake NF. Those model scenarios were based upon development scenarios determined by the USFS. The methodology for setting up and laying out these specific development scenario model runs is described below. These runs also assisted in defining model source data for the screening table runs.

Building downwash was not considered because the nearest receptors were well beyond all building or structure cavities. While actual locations may vary within the NF, the site selected was chosen at random, with a relatively flat area to locate the well field being the only criteria.

5.1 Fishlake National Forest Well Field Layout

Based on USFS development expectations, the 10 to 15 well Fishlake NF directional drilling oil field development model scenario featured 12 well pads over a small area, with potentially concentrated activity in the vicinity of each well. Figure 5.2-1 shows the representative AERMOD model layout for the hypothetical 12-well directional drilling oil field that was used as one of the specific development scenarios. The black circle represents a 3-square mile area boundary for the entire field. The underlying topographic map shows the hypothetical location modeled at Big Bench on the Joseph Peak United States Geological Survey (USGS) topographic map, approximately eight miles WSW of Joseph, Utah in the Fillmore District.

Figure 5.2-1 AERMOD Model: FNF 12-Well Directional, Drilling Field Scenario Facility Layout



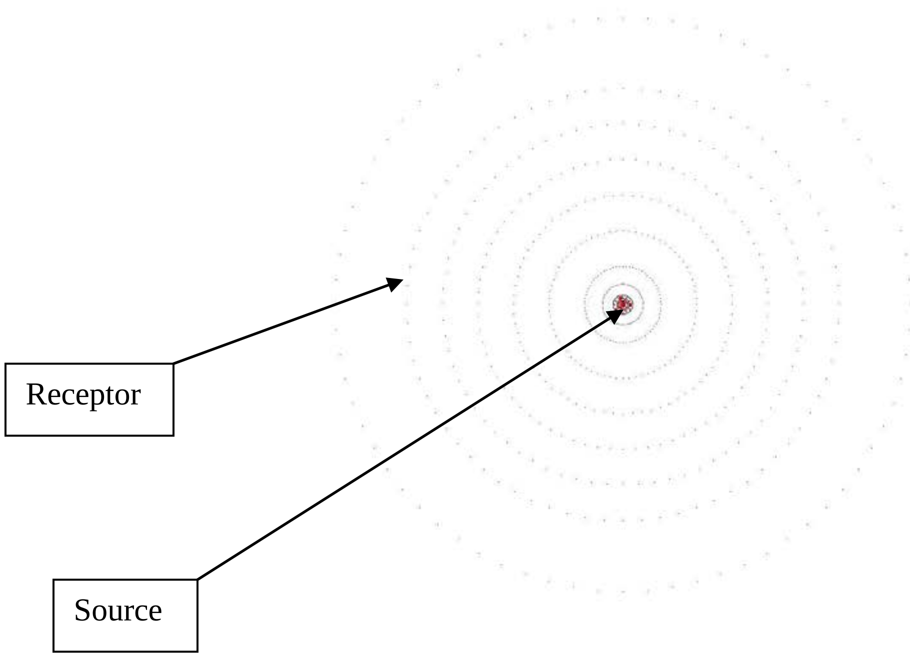
5.2 Exploratory Well Development Scenario (Scenario 1) Layout

The exploration development scenario model includes all emissions within an area consisting of a 5.9 acre pad with 9 to 10.7 acres of road and other surface disturbances around or atop the pad. Given that the nearest receptor was 250-meters away, the screening scenario with all sources collocated was assumed to be representative of an isolated exploratory oil well.

6.0 MODEL DOMAIN, MAPPING, AND RECEPTOR NETWORK

The model receptor network extends to 50 kilometers (km) from the area of activity. The receptor network for the analyses includes rings of receptors around the activity area at distances of 0.25, 0.5, 1, 2.5, 5, 10, 15, 20, 25, 30, 40 and 50. km (Figure 6.0-1). Receptors were placed at 5 degree intervals around the receptor rings within 50. The figure below shows the model receptor network. The model domain was set conservatively beyond the furthest extent of the receptor network.

Figure 6.0-1 Model Receptor Network



AERMOD was used for pollutant concentrations within 50 km (approximately 31 miles) of the activity area, consistent with UDAQ air quality modeling guidance.

6.1 Receptor Network

The receptor network for the screening modeling included seven source/receptor elevation differences. Separate model runs for each elevation difference scenario were performed with receptors at 2,500, 1,000, 500, and 100 feet above the source elevation, at the same elevation as the source, and at 1,000 and 2,500 feet below the source. These elevation difference scenarios include the five described in the modeling protocol, plus two more with receptors 500 feet and 100 feet above the model sources. Those added receptor elevations were based upon UDAQ comment that this elevation can often have highest impacts due to close proximity to the mean plume height.

In the case of the specific development scenario model runs, receptors were set at actual elevations corresponding to the distance rings described for the screening runs. The elevations of those receptors were calculated from USGS National Elevation Dataset (NED) data for receptors at each receptor ring distance (see Figure 6.0-1).

The ambient air boundary (point beyond which the public has access) for the specific development scenario model runs in the June 2008 version of this modeling report was the edge of the activity area (the 3-square mile area for the Fishlake NF directional drilling scenario). Based on agency comments, the analysis conducted in this current version of this modeling report refined the receptor network to begin at the fence surrounding the central processing area, assuming that the public could have access to areas beyond there, including around the well pads.

7.0 METEOROLOGICAL DATA

The normalized model analyses used to prepare the screening tables utilized AERMOD-based screening meteorological data files generated with the USEPA MAKEMET program. The inputs utilized in the MAKEMET program are summarized in Table 7.0-1 below.

Table 7.0-1 Proposed Physical Parameters for the Project Area

Parameter	Value
Minimum Wind Speed	0.5 m/s
Anem. Height	10 m
Number of Wind Directions	36
Starting Wind Direction	0 Degrees
Clockwise Increment	10 Degrees
Max and Min Temperature	273 and 390 K
Albedo	0.22
Bowen Ratio	0.65
Surface Roughness Length	0.504

For the Fishlake 12-well directional drilling scenario analyses, AERMOD model-ready meteorological data files for Milford, UT were provided by UDAQ. The data file, for years 2005-2009, consists of KMLF ASOS Station surface characteristics data merged with 1-minute ASOS (1/1/05-3/4/05 no 1-minute ASOS used; 3/05-12/09 1-minute ASOS used) and Desert Rock, NV upper air data.

8.0 LAND USE CLASSIFICATION AND AREA PHYSICAL CHARACTERISTICS

Rural dispersion coefficients are assumed to be appropriate for all locations where project development is anticipated. AERMOD defaults, including regulatory default options, were used. The USEPA AERSURFACE program was used to develop representative input variable for use in MAKEMET for the screening analysis. These values are summarized in Table 8.0-1 below.

Table 8.0-1 Proposed Physical Parameters for the Project Area

Parameter	Value
UTM Easting	381200.0 m
UTM Northing	4277400.0 m
Study Area	5.0 km
Temporal Resolution	Annual
Snow Cover	Yes
Reassign Months	No
Airport	No
Surface Moisture	Average

9.0 MODELING RESULTS

9.1 Screening Modeling

The results of the screening modeling analyses were translated into a set of screening tables as described in the DEIS modeling protocol. The pollutant concentration screening runs were prepared using a MAKEMET screening meteorological data file. The resulting screening tables conservatively estimate the maximum impact per pound per hour of emissions of 1-hr NOx and 1-hr SO_2 at a variety of distances from the proposed activity and elevations differences between the activity area and receptor.

Model results from the Fishlake verification scenario runs were used to perform quality assurance checks on the screening table initially prepared from screening modeling results. As a result of those quality assurance checks, specific recommendations were made for applying the screening table entries for near field short term NO_2 concentrations (the reasoning behind those refinements is discussed in Section 9.1 of this report).

The intention in preparing these criteria pollutant impact screening table is to conservatively estimate the potential impact and confirm, through the specific development scenario model analyses, that the screening process would not underestimate the actual impacts. With that verification, the screening table results can be used to make an initial check on compliance with applicable impact limits. If screening impact estimates from a development action show compliance with applicable impact limits for all receptors, as long as that development action was planned consistent with the assumptions included in the screening analysis, it would not be expected to show any air quality impact concerns with a site and development specific air quality impact analysis. If screening impact estimates from a development action do not show compliance with applicable impact limits for all receptors, that development action cannot be justified by the screening analysis. That development action might require stronger emission control or mitigation conditions, or might be justified by a site and development specific air quality impact analysis (which would remove some of the conservatism inherent in the screening analysis).

Screening tables are presented in Appendix A for each parameter modeled: 1-hr NOx and 1-hr SO_2. The details of the specific development scenario model runs, analyses of results, and screening table usage refinements made as a result of those specific development scenario model runs are described below.

Each Appendix A table shows maximum predicted impacts at each receptor ring distance for each source / receptor elevation difference scenario. The impacts included in the tables are normalized, based upon one pound per hour emissions. The normalized impacts can be used to estimate the potential impact of various O&G development scenarios considered in the Fishlake NF. Using the pound per hour emissions rate from any proposed project, the screening impact can be estimated by multiplying the screening table impact in Appendix A (in $\mu g/m^3$ per pound per hour emission) by the projected emission rate (in pounds per hour) for the project under consideration. The documentation clarifies that this is a screening tool for planning, leasing, and exploration estimates and conveys what level of development will require subsequent NEPA and/or air permitting action.

9.2 Development Scenario Verification Model Runs

As noted earlier, after the screening model runs, one potential development scenario described by the Fishlake NF was modeled to assess concentrations of 1-hr NOx and 1-hr SO_2. The activity was set at an arbitrarily chosen, conceivably developable location on the Fishlake NF. The location was chosen based upon the O&G production potential, where such information was available; otherwise they were selected by air quality scientists as topographically representative sites where development could occur.

Receptors were placed in 12 rings around each of these development scenarios, at intervals consistent with the screening modeling receptors. Receptor elevations in the specific development scenario modeling used actual elevations from USGS NED data. The primary goal was to estimate modeled impacts from the identified potential development scenario laid out in an area where it could conceivably occur. Another goal was to check if modeled impacts, at receptors set at actual locations in rings surrounding that development, were consistent with those predicted at those locations by the screening tables developed. As noted under the Model Receptor discussion, receptors were set assuming the outer edge of the developed area would be the ambient air boundary (the nearest location to which the public has access), which began at the fence of the central processing area.

Figure 5.2-1 above show the layout of the model for the multi-well scenario, and shows the actual location used for the specific development scenario modeling run analysis. Table 4.5-1 above shows the model source parameters used to simulate emissions from each scenario.

As noted under the meteorological data description, verifications for the Fishlake NF 12-well drilling scenario were performed using five years of meteorological data from Milford, UT.
For the above comparison, the maximum 8th highest maximum daily 1-hr value for each year averaged for all years for 1-hr NOx and the maximum 4th highest maximum daily 1-hr value for each year averaged for all years for 1-hr SO_2 were compared to the screening table result (see Appendix A).

The specific development scenario modeling run was considered as a realistic test of potential maximum impacts from the scenario modeled, even if the local wind patterns were not consistent with one of the meteorological data sets, since the results represent the conservative model predicted impacts from a variety of different wind flow patterns.

The goal of the verification process was to ensure that the screening tables produced conservative estimates of potential impacts (that they did not under predict impacts, which could result in problems if they were used for planning purposes), and that they were reasonable enough in estimating possible impacts to be potentially valuable planning tools.

“Model predicted maximum impacts” for each development scenario were prepared through the specific development scenario model runs described. For each meteorological data set modeled, the design value impact for each pollutant and each regulatory averaging period was calculated at each receptor distance up to 50 kilometers. The actual elevations of the receptors where the maximum model predicted impact occurred were documented and the source / receptor elevation difference calculated. Those maximum predicted impacts at each receptor ring were compared to the impact value estimated from the screening tables for the source / receptor elevation difference. Mean source elevations were used for the development scenario, which included real world considerations of elevation variation across the well field. This data set provided quality assurance checks for a good percentage of the values on the screening table. Verification receptors lower than the source elevations occurred more than those with higher elevations than the source. This occurred because the locations chosen for the specific development scenario model analyses had comparatively high elevations. However, there were still sufficient results to provide direct checks to almost half of the screening table results for receptors higher than the source elevation.

A representative section of the comparisons of the specific development scenario results with screening table results is included in Appendix B. Those verification analyses showed that the results from the screening table were quite conservative (overestimated values from specific development scenario analyses) for the closer receptors (especially those less than five miles from the development activity) and for long range transport (receptors more than 30 kilometers from the development activity). The exception to this is for 1-hr NOx impacts at receptors 40 km or more from the development activity. At these locations, the screening tables underestimate values from the specific development scenario. In the near field, this conservatism is because the screening runs had all emissions in one location, while actual field development spread the emissions (and hence impacts) over a larger footprint. This effect was minimized by starting the receptor network at the central processing area, and including the well fields in ambient air (accessible to public access). The screening scenario assumed very concentrated emissions that resulted in higher potential maximum impact predictions than those predicted from a well field scenario that spread activity over a few square miles. That concentration of emissions in the model runs supporting the screening table would seem to be appropriate for individual wells, as in an isolated exploratory well. Nonetheless, it is potentially conservative when considering emissions spread over a well field.

9.3 Specific Development Scenario Model Results and Verification against Screening Table Estimates

For 1-hr SO_2 impacts, verification efforts showed conservatism in the screening tables for all distances (receptors between 2.5 and 50 km), with the screening tables over-predicting impacts from 14% to 73% higher than the verification run impacts.

For 1-hr NOx impacts, the verification efforts showed conservatism in the screening tables for receptors between 2.5 km and 30 km of the source. Beyond 30 km, for receptors both near and well below the mean source elevation, the verification runs indicate that the screening tables under-predict NOx concentrations by up to 20%. However, the verification model run predicted impacts at 40 km and 50 km are 50% and 69% below the SIL, respectively, and represent only

2-3% of the 1-hr NOx NAAQs (188 ug/m^3). Therefore, at distances beyond 30 km, although the screening tables under-predict impacts, it is unlikely that actual development scenarios would approach the NAAQs.

9.4 Screening Model Results Interpreted for US Forest Service Identified Potential Development Scenario Impacts

For each of the three potential development scenarios described in Section 2.0, the equipment assumed to be operating to support the scenario development is described here. Also, the screening table data is interpreted consistent with emissions from that equipment at anticipated operational levels to estimate maximum potential impacts. Those impact projections are conservative because they are based upon conservative emission source layout and dispersion conditions.

9.4.1 Scenario 1: Exploratory Drilling

This scenario is assumed to include the following activities that affect air quality:

- Construction of 5.5-acre drilling locations.
- A diesel fuel fired drill rig engine with emissions based upon 13.5 tons NOx per well reported in the Western Regional Air Partnership (WRAP) Oil & Gas Emission Inventory prepared in December 2005 by Environ and the 2005 Wyoming field survey from which that data was developed, with actual emissions adjusted downward to be compliant with recent tiered engine requirements, and SO_2 emissions consistent with AP-42 assuming the 15ppm sulfur content in diesel scheduled to be required during the operational phase.
    - The WRAP study indicated the mean drilling time is approximately 90 days per well, continuously around the clock except for maintenance. Therefore, the longer term average impact predictions effectively assume four wells drilled back to back in relatively close proximity to each other.
- Construction of 1.1 miles of new access roads.
- Support traffic to supply, maintain, and staff the drilling effort.
- A low volume of flaring of natural gas during exploration, equal to 100 Mscf per year.

Table 9.4-1 below documents the predicted 1-hr NO_2 and 1-hr SO_2 concentrations at a variety of distances for three elevation difference scenarios. A more complete set of tables featuring more elevation differences and more receptor rings are included in Appendix A.

Table 9.4-1 Screening Impacts Predicted with the Exploratory Drilling Scenario

		Distance from Operating Area to Receptor (km)								
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors 2500 feet above source										
NO_2	1 hour	8.58	5.86	4.75	2.96	2.10	1.60	1.04	0.73	0.54
SO_2	1 hour	0.015	0.010	0.008	0.005	0.003	0.003	0.002	0.001	0.001

		Distance from Operating Area to Receptor (km)								
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors 500 feet above source										
NO_2	1 hour	10.97	7.13	5.45	3.326	2.348	1.782	1.148	0.801	0.602
SO_2	1 hour	0.020	0.011	0.008	0.005	0.003	0.003	0.002	0.001	0.001

		Distance from Operating Area to Receptor (km)								
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors at same elevation as source										
NO_2	1 hour	54.6	24.6	14.7	7.2	4.4	3.1	2.2	1.6	1.2
SO_2	1 hour	0.11	0.05	0.03	0.01	0.01	0.01	0.00	0.00	0.00

		Distance from Operating Area to Receptor (km)								
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors 1000 feet below source										
NO_2	1 hour	41.0	18.5	11.0	5.4	3.3	2.3	1.6	1.2	0.9
SO_2	1 hour	0.08	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00

Units for NOx and SO_2 concentrations are $\mu g/m^3$

Screening table and model results show air quality impacts concentrated in the near proximity of an isolated exploratory well drilling operation. Air concentrations of 1-hr NOx fall below the EPA defined significant impact levels (SIL) by ten kilometers (6.2 miles); concentrations of 1-hr SO_2 are below the SIL at all distances from the source. Screening tables show that compliance with NAAQS would be assured with the background concentrations expected in potential development areas.

9.4.2 Scenario 2: 12-Well Directional Drilling Development

This scenario is assumed to include the following activities that affect air quality:

- Construction of three 5.5-acre drilling locations.
- One diesel fuel fired drill rig engine with emissions based upon the 13.5 tons NOx per well reported in the WRAP Oil & Gas Emission Inventory prepared by Environ and the 2005 Wyoming field survey from which that data was developed, with actual emissions adjusted downward to be compliant with recent tiered engine requirements, and SO_2 emissions consistent with AP-42 assuming the 15ppm sulfur content in diesel scheduled to be required during the project's operational phase.
    - o The WRAP study indicated the mean drilling time is approximately 90 days per well, continuously around the clock except for maintenance. Therefore, the longer term average impact predictions effectively assume four wells drilled back to back in relatively close proximity.
- Construction of five miles of new access roads.

- Support traffic to supply, maintain, and staff the drilling and pumping effort.
- Six 1.0 MMbtu/hr heater / treater separators, two at each well pad.
- Twelve diesel powered 100 hp well pumps to extract oil, one for each well.
- One 0.5 MMbtu/hr dehydrator and one 500 HP compressor processing a low volume of natural gas at partial capacity.

Diesel well pumps are assumed because the development sites are expected to be remote from the electric power grid. Though a slight amount of natural gas production is included, producible natural gas is not routinely expected and is not anticipated in sufficient quantity to power the well pumps.

Table 9.4-2 on the following page documents the predicted 1-hr NO_2 and 1-hr SO_2 concentrations at a variety of distances for three elevation difference scenarios.

Table 9.4-2 Screening Impacts Predicted with the 12-Well Directional Drilling Scenario

Distance from Operating Area to Receptor (km)										
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors 2500 feet above source										
NO_2	1 hour	19.98	13.65	11.06	6.89	4.89	3.73	2.42	1.70	1.25
SO_2	1 hour	3.838	2.595	1.971	1.190	0.839	0.638	0.414	0.291	0.213

Distance from Operating Area to Receptor (km)										
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors 500 feet above source										
NO_2	1 hour	25.56	16.61	12.69	7.748	5.469	4.151	2.673	1.866	1.403
SO_2	1 hour	5.172	2.677	2.051	1.238	0.872	0.663	0.428	0.300	0.220

Distance from Operating Area to Receptor (km)										
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors at same elevation as source										
NO_2	1 hour	127.3	57.4	34.2	16.7	10.3	7.3	5.1	3.8	2.8
SO_2	1 hour	26.92	12.48	7.38	3.50	2.08	1.44	1.11	0.82	0.60

Distance from Operating Area to Receptor (km)										
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)
Receptors 1000 feet below source										
NO_2	1 hour	95.5	43.1	25.7	12.6	7.7	5.3	3.8	2.8	2.1
SO_2	1 hour	20.19	9.36	5.53	2.63	1.56	1.08	0.84	0.61	0.45

Units for NOx and SO_2 concentrations are $\mu g/m^3$

One hour NOx impacts for a receptor at the same elevation as the source, within one kilometer of the source conservatively estimated from the screening table are shown to approach but not exceed the NAAQS with anticipated background concentrations added in the immediate vicinity of development activity. However, 1-hr NOx impacts for all other distance/source-receptor elevation differences and all 1-hr SO_2 impacts are estimated by screening to be well below the NAAQs standards with anticipated background concentrations added in. Air impacts for both pollutants fall below the respective SILs beyond 20 km. Because the impacts are shown to exceed the SIL at receptors closer than 20km to the source, this screening analysis cannot rule out the need to perform a cumulative impact analysis for 1-hr NOx or 1-hr SO_2.

The conservatism in the screening tables is shown by the results of the verifications prepared from modeling runs for potential development operational scenarios. Specific development scenario modeling analyses with realistic layout of equipment in potentially sensible locations and representative meteorological data indicate low probability of exceeding NAAQS, increments and/or thresholds nearby. Specific development scenario modeling results show that actual development scenarios that do not pass the screening tests could be shown to have air quality impacts within acceptable limits with refined air quality modeling. The specific development scenario model analyses give only an indication of the extent to which impacts from refined modeling could be lower than those estimated from the screening tables.

The emission inventory for this analysis was conservative in that it assumed one new well was being drilled while the full field is operating, and also assumed that diesel pumps would be used at each well head. NOx and SO_2 impacts would decrease by approximately 20 percent if either no well drilling occurred simultaneously with the operation of 12-wells, or if enough natural gas was recovered onsite to fuel the well pumps. NOx and SO_2 impacts would be approximately 90 percent lower if electric power lines brought power onsite, and no fuel was needed to operate the well pumps.

9.5 Screening Table Summary

These estimates of potential impacts are based upon emission profiles consistent with the recommendations of the FNF, the USEPA, and the (Utah Department of Environmental Quality (UDEQ), and with the NEPA analysis and associated requirements or mitigation measures defined in the EIS. These predicted distances to regulatory threshold impact limits are only for gauging if a more detailed analysis or a cumulative impact analysis should be considered. The model and screening tables can be used as in the example given in Table 9.4-2 to gauge the need for cumulative impact analysis.

9.5.1 Screen Table Conservatism

In summary, the verification process described above and documented in Appendix B resulted in demonstrating that the results in the screening tables were conservative, with the exception of 1-hr NOx impacts beyond 30 km.

As discussed in Section 9.3 above, beyond 30 km the verification runs indicate that the screening tables under-predict NOx concentrations by up to 20%. However, with verification model predicted impacts of 1-hr NOx approximately 2-3% of the NAAQs at these distances, it is not anticipated that impacts from any actual development scenario would exceed the NAAQs at these distances.

These analyses reveal that screening tables can be used to prepare conservative assessment of impacts of any specific action or alternative consistent with the assumptions included. Specific development scenario analyses confirm that when applied to representative potential development scenarios (consistent with the assumptions documented for the screening analysis), the screening tables generally do not under predict impacts predicted by site and project impact analyses (with the caveat of 1-hr NOx beyond 30 km, as discussed above).

9.5.2 Cumulative Impact Analyses

Assuming the interim SIL represents the future Class 1 SIL, the screening analysis for a single exploration well (Scenario 1), shows the need to perform a cumulative impact analysis for 1-hr NOx for developments within 10 km of a Class 1 area. All Scenario 1 estimated impacts for 1-hr SO_2 are below the SIL, therefore, no cumulative impact analysis would be required. The screening analysis for the “typical 12-well field” scenario (Scenario 2) shows the need to perform a cumulative impact analysis for 1-hr NOx for developments within 20 km of a Class I area and within 5 km of a Class I area for 1-hr SO_2.

APPENDIX A

Dixie and Fishlake National Forests

Screening Tables for Prompt Initial Estimates of

Likely Impacts from Oil and& Gas Development

SO_2		Distance from Operations to Receptor (km)											
		0.25	0.5	1	2.5	5	10	15	20	25	30	40	50
Receptor Elevation (ft) compared to Source Elevation	2500												
	1hr ave (ug/m3)	2.20	1.75	1.55	1.05	0.80	0.48	0.34	0.26	0.20	0.17	0.12	0.09
	1000												
	1hr ave (ug/m3)	4.32	1.84	1.55	1.05	0.80	0.48	0.34	0.26	0.21	0.17	0.12	0.09
	500												
	1hr ave (ug/m3)	6.52	3.40	2.09	1.08	0.83	0.50	0.35	0.27	0.21	0.17	0.12	0.09
	100												
	1hr ave (ug/m3)	41.82	25.03	14.82	7.30	4.09	2.17	1.45	1.06	0.82	0.65	0.43	0.30
	0												
	1hr ave (ug/m3)	22.08	12.31	10.88	5.05	2.98	1.42	0.84	0.58	0.52	0.45	0.33	0.24
	-1000												
	1hr ave (ug/m3)	16.56	9.23	8.16	3.78	2.24	1.06	0.63	0.44	0.39	0.34	0.25	0.18
	-2500												
	1hr ave (ug/m3)	16.56	9.23	8.16	3.78	2.24	1.06	0.63	0.44	0.39	0.34	0.25	0.18

NOx		Distance from Operations to Receptor (km)											
		0.25	0.5	1	2.5	5	10	15	20	25	30	40	50
Receptor Elevation (ft) compared to Source Elevation	2500												
	1hr ave (ug/m3)	1.33	0.99	0.88	0.60	0.49	0.30	0.22	0.16	0.13	0.11	0.08	0.06
	1000												
	1hr ave (ug/m3)	2.30	1.07	0.90	0.63	0.51	0.32	0.23	0.18	0.14	0.12	0.08	0.06
	500												
	1hr ave (ug/m3)	3.69	1.90	1.13	0.73	0.56	0.34	0.24	0.18	0.15	0.12	0.08	0.06
	100												
	1hr ave (ug/m3)	19.96	11.95	7.15	3.54	2.03	1.12	0.76	0.56	0.44	0.35	0.24	0.17
	0												
	1hr ave (ug/m3)	11.63	7.02	5.62	2.54	1.51	0.74	0.46	0.32	0.26	0.22	0.17	0.12
	-1000												
	1hr ave (ug/m3)	8.72	5.27	4.22	1.90	1.13	0.55	0.34	0.24	0.19	0.17	0.12	0.09
	-2500												
	1hr ave (ug/m3)	8.72	5.27	4.22	1.90	1.13	0.55	0.34	0.24	0.19	0.17	0.12	0.09

APPENDIX B

Dixie and Fishlake National Forests

Statistics Comparing Verification Run Results

With Initial Screening Table Results

Fishlake NF 12 Well Drilling Scenario

1-hr SO_2 Verification: Refined Modeling Results vs. Screening Table

	1-hr SO2					
Distance from source	refined model predicted impact	A pred imapct per lb/hr emission	Receptor elevation	source receptor elev diff (rec el - source el)	B scr table results for src/red ht diff	(A-B)/B
km	**ug/m3**	**/lb/hr**	**m**	**ft**	**Scr Tab**	**%diff**
0.25	14.95	6.05	2492.5	-62.23	22.08	-73%
0.5	18.04	7.30	2515.4	12.88	12.31	-41%
1	17.00	6.88	2487.5	-78.63	10.88	-37%
2.5	6.21	2.51	2380.2	-430.58	5.05	-50%
5	4.37	1.77	2473.8	-123.57	2.98	-41%
10	1.98	0.80	2113.8	-1304.37	1.06	-25%
15	1.62	0.66	2472.1	-129.14	0.84	-22%
20	1.16	0.47	2455.8	-182.61	0.58	-19%
25	1.00	0.40	2461.3	-164.57	0.52	-22%
30	0.72	0.29	2295.2	-709.38	0.34	-14%
40	0.51	0.21	2518.5	23.05	0.33	-37%
50	0.40	0.16	2504.1	-24.18	0.24	-32%

Fishlake NF 12 Well Drilling Scenario

1-hr NOx Verification: Refined Modeling Results vs. Screening Table

	1-hr NOx					
Distance from source	refined model predicted impact	A pred imapct per lb/hr emission	Receptor elevation	source receptor elev diff (rec el - source el)	B scr table results for src/red ht diff	(A-B)/B
km	**ug/m3**	**/lb/hr**	**m**	**ft**	**Scr Tab**	**%diff**
0.25	172.46	7.62	2541	96.85	19.95	-62%
0.5	132.55	5.85	2540.7	95.86	11.95	-51%
1	81.12	3.58	2540.3	94.55	7.15	-50%
2.5	33.10	1.46	2533.9	73.56	3.54	-59%
5	19.07	0.84	2546.4	114.56	2.03	-58%
10	10.85	0.48	2500.2	-36.98	0.74	-35%
15	8.47	0.37	2472.1	-129.14	0.46	-18%
20	6.64	0.29	2477.4	-111.76	0.32	-9%
25	5.40	0.24	2385.4	-413.52	0.26	-7%
30	4.45	0.20	2653.7	466.50	0.22	-12%
40	3.99	0.18	2518.5	23.05	0.17	6%
50	2.50	0.11	2213	-978.99	0.09	20%